REMARKS

Claims 13, 15, 17, 19-21, 23-26, 29-32, and 34-36 are all claims presently pending in the application. New Claims 35 and 36 have been added. Claims 14, 16, 18, 22, 27, and 28 have been canceled without prejudice or disclaimer. By this Amendment, reconsideration is respectfully requested.

Claims 24-25 stand rejected upon informalities (e.g., 35 U.S.C. § 112, second paragraph). Claims 24-25 are objected under 37 C.F.R. Part 1.75(c). Claims 13-21, 23-32, and 34 stand rejected on prior art grounds.

Claim 32 stands rejected under 35 U.S.C. § 102(b) as being anticipated by or, in the alternative, under 35 U.S.C. § 103(a) as obvious over Thess, et al. article and as being anticipated by Pradeep, et al article. Claims 13, 19, 24-26, and 32 stand rejected under 35 U.S.C. § 102(e) as being anticipated by Lieber, et al. Claims 14-15, 18, 20-21, 23, 29-31 and 34 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Lieber. Claims 13-16, 19, 23-25, 32, and 34 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Loutfy, et al. Claims 17-18, 20-21, and 26-31 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Loutfy.

These rejections are respectfully traversed in view of the following discussion.

It is further noted that, notwithstanding any claim amendments made herein, Applicant's intent is to encompass equivalents of all claim elements, even if amended herein or later during prosecution.

It is noted that the amendments are made only to more particularly define the invention and not for distinguishing the invention over the prior art, for narrowing the scope of the claims, or for any reason related to a statutory requirement for patentability.

I. THE CLAIMED INVENTION

Applicant's invention, as disclosed and claimed, for example by independent claim 13, and similarly by independent claims 26, 32 and 34, is directed to a laser irradiation target for the manufacture of carbon nanotubes by laser ablation.

The target includes a fullerene powder and a catalyst powder pressed together with the fullerene powder to form a pellet. The laser irradiation target includes the catalyst powder in a range of 4.5 at % and 5.5 at %. (See Page 5, lines 3-7; Page 8, line 27-Page 9, line 5 and lines 27-30; and Page 11, lines 23-27).

In a second embodiment, as disclosed and claimed, for example by independent claim 32, is directed to a laser irradiation target. The laser irradiation target includes a fullerene powder and a catalyst powder combined with the fullerene powder to form a solid unit. The laser irradiation target includes the catalyst powder in a range of 4.5 at % and 5.5 at %. The target forms a carbon nanotube when subjected to a laser ablation. (See Page 5, lines 3-7; Page 8, line 27-Page 9, line 5 and lines 27-30; and Page 11, lines 23-27).

Conventional targets are graphite carbon based materials suitable for producing multi-wall carbon nanotube structures at generally high temperatures. However, such conventional targets can only be used at high temperatures and with complex equipment. (See Application, Page 1, line 25-Page 2, line 3; Page 2, lines 20-22 and 26-29; and Page 3, lines 11-30).

An aspect of this inventive combination is that the laser irradiation target includes the catalyst powder in a range of 4.5 at % and 5.5 at %. This aspect permits a carbon nanotube to be produced at low process temperature using a short pulse-width laser ablation method. (See Page 1, lines 2-7; Page 4, lines 7-10; Page 5, lines 10-15; and Page 9, lines 10-16).

As a result of this inventive structure, the low process temperatures permit the use of

simple production equipment while reducing manufacturing cost and maximizing the yield of the nanotubes thus increasing the quality of electronic circuit chips. (See Page 4, lines 7-10; Page 7, lines 26-28; Page 9, lines 10-16).

II. THE 35 USC §112, SECOND PARAGRAPH, REJECTIONS AND 37 CFR 1.75(c) OBJECTION

Claims 24 and 25 stand rejected under 35 U.S.C. §112, second paragraph. In response Applicant has amended claim 24 to recite a temperature range of 350-450^{0}C. Applicant has further amended claim 25 to recited a pulse width of "8ns." Both changes are consistent with the specification. (See Specification, Page 9, lines 11-20; and Page 11, lines 12-22).

In response to the 37 C.F.R. 1.75(c) objection, Applicant has amended claims 24 and 25 to recite,"said laser ablation apparatus," which properly limits the independent claim.

In view of the foregoing, the Examiner is respectfully requested to withdraw the rejections and objections.

III. THE PRIOR ART REJECTIONS

A. The Thess, et al. Reference

Thess, et al. ("Thess") fails to teach or suggest the features of independent claim 32, including a laser irradiation target includes the catalyst powder in a range of 4.5 at % and 5.5 at %. A second feature is that the target forms a carbon nanotube when subjected to a laser ablation. (See Page 5, lines 3-7; Page 8, line 27-Page 9, line 5 and lines 27-30; and Page 11, lines 23-27).

As noted above, in Applicant's invention (e.g., as defined in Claim 32), the inventive

laser irradiation target includes a laser irradiation target includes the catalyst powder in a range of 4.5 at % and 5.5 at %. Thus, as indicated above, carbon nanotubes are produced at a low process temperature using a short pulse-width of the laser. (See Page 1, lines 2-7; Page 4, lines 7-10; Page 5, lines 10-15; and Page 9, lines 10-16).

Instead, Thess discloses that some kinds of metal and fullerenes contribute to growing nanotubes. However, it is not presumed from Thess that fullerenes themselves are used for a laser irradiation target nor that the temperature in an oven can be lowered from 1100°C to about 400°C, as in the claimed invention. In particular, the Thess target structure only teaches a graphite-nickel-cobalt powder mixture to produce single-wall nanotubes at 1200°C. (See Thess at Abstract, Page 483, i.e., page 1). In particular, "samples were prepared by laser vaporization of graphite rods doped with 1.2 at.% of a 50/50 mixture of Co and Ni powder (~1 micrometer particle size) at 1200°C in flowing argon at 500 Torr, followed by heat treatment in vacuum at 1000°C to sublime out C_{60} and other small fullerenes. Thess produces "100 to 500 [single-wall fullerene nanotubes] SWNT in a two-dimensional triangular lattice." (See Thess at Abstract; and Page 487, i.e., Page 6, Column 1, References and Notes Section, Note Number 7).

Accordingly, Thess, like the other conventional art, uses conventional targets with complex equipment at high operating temperatures, well above Applicant's operating laser temperature range of 350-450 °C. (See Application, Page 1, line 25-Page 2, line 3; Page 2, lines 20-22 and 26-29; and Page 3, lines 11-30).

Indeed, Thess discloses graphite rods doped with 1.2 at.% of a 50/50 mixture of Co and Ni powder (~1 micrometer particle size) not a catalyst powder in a range of 4.5 at % and 5.5 at %. Therefore, Thess does not disclose, teach or suggest a laser irradiation target

includes the catalyst powder in a range of 4.5 at % and 5.5 at % as recited in Applicant's invention.

Consequently, the conventional Thess structure is unsuitable for achieving at least one object of the invention, which includes producing a carbon nanotube at low process temperatures using a short pulse-width laser ablation method. Thus, Applicant's target combined with the low process temperatures permit the use of simple production equipment while reducing manufacturing cost and maximizing the yield of the nanotubes and increasing the quality of the electronic circuit chips (See Page 1, lines 2-7; Page 4, lines 7-10; Page 5, lines 10-15; Page 7, lines 26-28; and Page 9, lines 10-16).

For at least the reasons outlined above, Applicant respectfully submits that Thess does not disclose, teach or suggest all the features of independent claim 32, and thus does not anticipate or render obvious the subject matter of claim 32. Withdrawal of the rejection of claim 32 is respectfully requested.

For the reasons stated above, the claimed invention is fully patentable over the cited reference.

B. The Pradeep, et al Reference

To make up for the deficiencies of Thess, the Examiner relies on Pradeep, et al. ("Pradeep"). Pradeep fails to do so.

By contrast, Pradeep does not have the same aim as Thess.

Pradeep discloses an FeC_{60} adduct, i.e., a non-mixture, in the solid state including formation of "an FeC_{60} complex in the gas phase by means of a ligand-exchange reaction and have also characterized NiC_{60} and $Ni(C_{60})_2$ in the gas phase." (See Pradeep, 1st Paragraph, lines 7-10; and 2nd Paragraph, lines 1-3).

Nothin within Pradeep, which relates to an FeC_{60} adduct in the solid state, i.e., a coordination compound, suggests a graphite-nickel-cobalt powder mixture to produce single-wall nanotubes as disclosed in Thess. Thus, Thess <u>teaches away</u> from being combined with Pradeep

Therefore, one of ordinary skill in the art would not have combined these references, <u>absent hindsight</u>. It is clear that the Examiner has simply read Applicant's specification and conducted a keyword search to yield Thess and Pradeep. Further, the Examiner provides <u>no</u> motivation or reason to combine other than to assert that it would have been obvious to one having ordinary skill in the art. <u>Such an assertion does not take into account the distinct structural differences and operations of the two references as indicated above, and further discussed below. Thus, the Examiner's assertion attempts to solve a potential problem which does not ever exist with either Thess or Pradeep, and this assertion is further proof of the Examiner's use of impermissible hindsight</u>.

Secondly, even if combined, the references do not teach or suggest at least two features of independent claim 32, including a <u>laser irradiation target includes the catalyst powder in a range of 4.5 at % and 5.5 at %.</u>

As indicated above, Thess does not disclose, teach or suggest the invention, and Pradeep does not make up for these deficiencies.

In contrast, <u>Pradeep discloses producing fullerenes incorporated with metal atoms but does not teach that the fullerenes mixed with the metal catalyst is used as a laser irradiation target. The present invention does not teach or use fullerenes including metal atoms.</u> In particular, Pradeep only recites an FeC_{60} adduct, i.e., a non-mixture, in the solid state including formation of "an FeC_{60} complex in the gas phase by means of a ligand-exchange

reaction and have also characterized NiC_{60} and $Ni(C_{60})_2$ in the gas phase." Pradeep, accordingly, does not disclose a catalyst powder, let alone the catalyst powder in a range of 4.5 at % and 5.5 at % as recited in Applicant's invention. Instead, the Fe adduct of C_{60} was produced through "contact-arc vaporization of graphite in an atmosphere of $Fe(CO)_5$." (See Pradeep, 1st Paragraph, lines 7-10; and 2nd Paragraph, lines 1-3). NiC_{60} and $Ni(C_{60})_2$ are coordination compounds formed from the ligand-exchange reaction where the Ni like Fe is "inside the cage of C_{60}." (See Pradeep, 6th Paragraph, lines 3-6). As indicated, this coordination compound is a stable product formed from the reaction of Ni and C_{60}, which can be represented by a chemical formula, whereas Applicant discloses a catalyst powder and a fullerene powder which can not be represented by a chemical formula.

Accordingly, NiC_{60} and $Ni(C_{60})_2$ are coordination compounds not a catalyst, let alone, a catalyst powder as recited in the invention. Similarly, the FeC_{60} adduct is not a fullerene, let alone a fullerene powder as recited in the invention. Since Pradeep does not recite either a fullerene powder or a catalyst powder, Pradeep is deficient.

For emphasis, Applicant discloses that a irradiation target includes the catalyst powder in a range of 4.5 at % and 5.5 at % whereas Pradeep does not disclose a catalyst powder, let alone the catalyst powder in a range of 4.5 at % and 5.5 at %. Pradeep does not disclose, teach or suggest, at least two features of claim 32, including a laser irradiation target inlcudes the catalyst powder in a range of 4.5 at % and 5.5 at %. Thus, Applicant traverses the assertion to combine these references.

For the reasons stated above, the claimed invention, and the invention as cited in independent claim 32, are fully patentable over the cited references.

C. The Lieber, et al. Reference

Lieber, et al. ("Lieber") fails to teach or suggest the features of independent claims 13, and similar independent claims 26, 32 and 34, including a laser irradiation target includes the catalyst powder in a range of 4.5 at % and 5.5 at %. (See Page 5, lines 3-7; Page 8, line 27-Page 9, line 5 and lines 27-30; and Page 11, lines 23-27).

As noted above, in Applicant's invention (e.g., as defined in Claim 13), the inventive laser irradiation target includes a laser irradiation target includes the catalyst powder in a range of 4.5 at % and 5.5 at %. Thus, as indicated above, the carbon nanotubes are produced at a low process temperature, for example as recited in claim 24, using a short pulse-width, for example as recited in claim 25, of the laser. (See Page 1, lines 2-7; Page 4, lines 7-10; Page 5, lines 10-15; and Page 9, lines 10-16).

Applicant agrees with the Examiner that Lieber "does not exemplify the claim features (C_{60}, powder)." (See Office Action, Page 3, 3rd Paragraph).

Instead, Lieber discloses producing carbide nanorods from a compound of graphite and metal catalyst. The compound, however, is not used as a laser irradiation target. Thus, the purpose of Lieber is different from the present invention.

In particular, Lieber only teaches the preparation of carbide nanorods where a volatile species source, a carbon source and a supported metal catalyst are placed in a furnace and heated between 500-2500°C to form the nanorod. (See Liebers at Abstract; and Column 1, lines 45-56). In particular, "the volatile species source includes silicon. The carbon source can include. . . graphite, . . ., a fullerene, ... The supported metal catalyst and the carbon source can be mixed together. The supported metal catalyst is a carrier coated with a metal catalyst, . . . , including . . . cobalt, . . . , nickel, . . . , or a combination thereof." (See Column

2, lines 28-60; Column 5, lines 10-55; and Column 10, lines 14-35, i.e., Example 3).

Indeed, Lieber teaches placing the reactants in a furnace whereas Applicant's reactants are placed in "a laser ablation apparatus." (See Lieber at abstract; Column 1, lines 5-11 and 45-65; Column 2, lines 28-60; Column 5, lines 10-55; and Column 10, lines 14-35, i.e., Example 3). Since Lieber does not teach or suggest a laser ablation process, in which the catalyst powder range of 4.5 at % and 5.5 at % is important to the process, Lieber, therefore, does not teach Applicant's range where the laser irradiation target includes the catalyst powder in a range of 4.5 at % and 5.5 at %.

Accordingly, Lieber, like the other conventional art, uses conventional targets with complex equipment at high temperatures, i.e., in a range of 500-2500°C, well above Applicant's operating laser temperature range of 350-450 °C, for example as cited in claim 24. (See Application, Page 1, line 25-Page 2, line 3; Page 2, lines 20-22 and 26-29; and Page 3, lines 11-30).

Finally, Applicant's catalyst powder in a range of 4.5 at. % to 5.5 at.%, permits "an unexpected result"of being able to combine these reactants using a laser ablation apparatus at a "low" operating temperature of 350-450^{0}C, for example as recited in amended claim 24. Therefore, Lieber does not disclose, teach or suggest including Applicant 's invention as recited in claim 13, and similar claims 26, 32 and 34, of the invention.

Consequently, the conventional Lieber structure is unsuitable for producing a carbon nanotube at low process temperatures using a short pulse-width laser ablation method. Thus, Applicant's target combined with the low process temperatures permit the use of simple production equipment while reducing manufacturing cost and maximizing the yield of the nanotubes and increasing the quality of the electronic circuit chips (See Page 1, lines 2-7;

Page 4, lines 7-10; Page 5, lines 10-15; Page 7, lines 26-28; and Page 9, lines 10-16).

For at least the reasons outlined above, Applicant respectfully submits that Lieber does not disclose, teach or suggest all the features of independent claims 13, 26, 32 and 34, and related dependent claims 15, 19-21, 23-25, and 29-31. Thus, Lieber does not anticipate or render obvious the subject matter of claims 13, 26, 32, and 34.

The dependent claims are patentable not only by virtue of their dependency from the respective independent claims, but also by the additional limitations they recite.

For the reasons stated above, the claimed invention is fully patentable over the cited reference.

D. The Loufty, et al. Reference

Loufty, et al. ("Loufty") fails to teach or suggest the features of independent claims 13, and similar independent claims 26, 32 and 34, including a laser irradiation target includes the catalyst powder in a range of 4.5 at % and 5.5 at %. (See Page 5, lines 3-7; Page 8, line 27-Page 9, line 5 and lines 27-30; and Page 11, lines 23-27).

In contrast, as noted above, to Applicant's invention (e.g., as defined in Claim 13), Loufty discloses a compound of a fullerene and carbon as an electrode for an electrochemical reaction. In the Loufty reference, the carbon is not expected to work as a catalyst for growth of nanotubes or a laser irradiation target but as a conductive material and a catalyst for an electrochemical reaction.

In particular, Loufty only teaches an electrochemical cell including a proton donor electrolyte in contact with "first and second electrodes one of which consists essentially of a fullerene in contact with a conductive material." This structure "stor[es] hydrogen and

electrical energy through hydrogentation of the new form of carbon referred to as fullerene or Buckminsterfullerene." (See Loufty at Abstract; and Column 1, lines 5-10; and Column 2, lines 5-20). The electrode is 10-50% silver or carbon (by volume) whereas Applicant teaches a laser irradiation target includes the catalyst powder in a range of 4.5 at % and 5.5 at %. (See Column 3, lines 60-67; Column 5, lines 1-65; and Column 7, lines 1-20 and 60-65).

Indeed, Loufty teaches an electrochemical fullerene system used for storing hydrogen and electrical energy where the fullerene powder is mixed with a conductive matrix to form an electrode stored in a stainless steel container. In contrast, Applicant's invention teaches a fullerene powder and a catalyst powder, which are "pressed together" in a laser ablation apparatus unrelated to an electrochemical cell.

For emphasis, Loufty's electrochemical battery in a stainless steel container has nothing to do with Applicant's invention pertaining to formation of nanotubes in a laser ablation apparatus. Therefore, Loufty does not disclose, teach or suggest including a laser irradiation target includes the catalyst powder in a range of 4.5 at % and 5.5 at % as recited in claim 13, and similar claims 26, 32 and 34, of the invention.

Consequently, the Loufty structure is unsuitable for producing a carbon nanotube at low process temperatures using a short pulse-width laser ablation method. Thus, Applicant's target combined with the low process temperatures permit the use of simple production equipment while reducing manufacturing cost and maximizing the yield of the nanotubes and increasing the quality of the electronic circuit chips (See Page 1, lines 2-7; Page 4, lines 7-10; Page 5, lines 10-15; Page 7, lines 26-28; and Page 9, lines 10-16). Applicant traverses this rejection and, in particular, the assertion that "forming the claimed mixtures represents an obvious optimization." (See Office Action, Page 3, 4th Paragraph).

For at least the reasons outlined above, Applicant respectfully submits that Loufty does not disclose, teach or suggest all the features of independent claims 13, 26, 32 and 34, and related dependent claims 15, 19-21, 23-25, and 29-31. Thus, Loufty does not anticipate or render obvious the subject matter of claims 13, 26, 32, and 34.

The dependent claims are patentable not only by virtue of their dependency from the respective independent claims, but also by the additional limitations they recite.

For the reasons stated above, the claimed invention is fully patentable over the cited reference.

IV. FORMAL MATTERS AND CONCLUSION

In view of the foregoing, Applicant submits that claims 13, 15, 17, 19-21, 23-26, 29-32, and 34-36, all the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

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